Multiscale Modelling of Dynamic Damage by Micro-Voiding: Application to Impact Tests on Tantalum

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Abstract

A model of dynamic damage by void nucleation and growth is proposed for elastic–viscoplastic materials sustaining intense loading. The model is dedicated to ductile materials for which fracture is caused by microvoiding. The material contains potential nucleation sites where microvoids are generated when the local pressure overcomes the nucleation pressure. A probability density function is adopted to describe the fluctuation of the nucleation pressure within the material. The void growth is described by a hollow sphere model in which micro-inertia effects are accounted for. Matrix weakening due to void growth is also included. Finite element simulations of plate impact tests have been carried out and compared to experiments on tantalum. From simulations based on the proposed model, an increase in spall strength with shock intensity is observed. Therefore, the relationship between the velocity pullback and spall strength usually assumed in the literature (based on the acoustic approach) seems to be inadequate. Velocity profiles are obtained for different flyer thicknesses and different impact velocities with close agreement with experiments.

Bio-Sketch

Dr. Molinari is Professor of Mechanical Engineering at the Paul Verlaine University-Metz, France. He received M.S. degrees in Mechanics and Mathematics from Louis Pasteur University, Strasbourg in 1971 and 1972 and completed his Habilitation Thesis in 1979 at the University Paul Verlaine. He was one of the two founders in 1982 of the CNRS Laboratory of Physics and Mechanics of Materials where he is presently conducting research on multiscale modeling of material behavior, strain localization, dynamic damage at high strain rate loading and high speed processes. In addition to his career at the University Paul Verlaine, he was also Professeur chargé de cours at Ecole Polytechnique in Paris for fourteen years. He was on sabbatical leaves and held invited Professorships at Brown University, California Institute of Technology, tUniversity of California at San Diego, Johns Hopkins University, Max Planck Group at Dresden, University of Western Australia, Hamburg-Harburg Technical University, the Institute of Mathematics of Bucharest and Polish Academy of Sciences in Warsaw.

If you are interested in meeting with Dr. Molinari, please contact Min Zhou at min.zhou@gatech.edu **or Cecelia Jones at** Cecelia.jones@me.gatech.edu